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Research Paper

Value Capture in the Global Electronics Industry: Empirical Evidence for the "Smiling Curve" Concept

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ABSTRACT This research asks who captures the greatest value in the global electronics industry by testing the concept of the "smiling curve", which predicts that the greatest value is captured by upstream and downstream firms, and the lowest value is captured in the middle of the value chain. We test the concept using the Electronic Business 300 data-set for 2000–2005. We find that lead firms and component suppliers earn higher gross margins and net margins compared to contract manufacturers. However, the differences are minimal for return on assets (ROA) and return on equity (ROE). We also find that active component suppliers gain higher profits than passive component suppliers. These findings suggest that the smiling curve is right if value is defined in terms of gross margins, but the cost of sustaining a position on either end of the curve is so high that returns on investment are similar across the curve.

KEY WORDS: Electronics industry, value chain, smiling curve, lead firm, component supplier

1. Introduction

In today's global electronics industry, companies outsource production and even product development to global networks of contract manufacturers (CMs), original design manufacturers (ODMs) and component suppliers. In such global production networks, value created from a successful product is distributed not only to a lead firm, usually the company whose brand appears on the product, but also to partners in the firm's value chain, such as component suppliers as well as CMs/ODMs. While the lead firm captures a significant portion of

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the value by focusing on the creation, penetration and defense of markets for the product, other firms also benefit by pursuing core technological innovations and offering complementary products or services. Since no single company is the source of all innovations, a lead firm works closely with global partners to bring new products to market (Linden *et al.*, 2009).

This paper addresses the question of who captures the greatest value in such global value chains by empirically testing the "smiling curve" concept in the electronics industry. The smiling curve (Shih, 1996; Everatt *et al.*, 1999) or the smile of value creation (Mudambi, 2008) represents a pattern of value-added along the value chain. It predicts that higher value is added both upstream (at the input end) and downstream (at the output end), with the lowest value-added in the middle of the value chain. From the firm's perspective, however, the goal is not to add value but to capture value in the form of profits. Thus, this research examines whether the "smiling curve" concept can be applied to value captured by firms in each part of the global value chain.[1]

This research can inform us about the importance of position in the value chain for the profitability of firms, and also for the financial benefits to countries participating in global value chains. Thus, beyond the question of which firms capture more value, we also raise a question about the value captured by countries, particularly between advanced and emerging economies. Given that there tend to be more lead firms and component suppliers in advanced economies, the smiling curve would predict that the value captured by firms in these economies is higher than that by firms in newly emerging economies, which tend to specialize more in labor-intensive assembly.

We hypothesize these relationships and test the hypotheses by using data from the Electronic Business 300 data-set. We find that lead firms and component suppliers capture more value as measured by gross margin and net margin, compared to various contract manufacturers (e.g. CMs/ODMs). We also find that active component suppliers gain higher profits than passive component suppliers[2] and that firms based in advanced economies earn higher value in terms of gross margins, compared to firms based in emerging economies. Our findings suggest that high levels of innovation, sales and marketing, and branding can build barriers to entry and help firms capture higher profits in global production networks.

In the next section, we describe the concept of the "smiling curve", analyze the concept based on resource-based theory, dynamic capabilities and industrial economics, and propose hypotheses. Section 3 describes our research methods and data sources. We present our results in Section 4. Implications of the results and conclusions are provided in Section 5.

2. Theoretical Background

2.1 The Concept of the Smiling Curve

A firm's value chain activities can be broadly grouped into three categories: the upstream (input), the downstream (output or market) and the middle (Mudambi, 2007, 2008). While

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[1] Value capture, which can be indicated by gross profit, does not equal value-added because it excludes the amount of wages for direct labor (workers who are involved in production, that is, converting inputs to a salable product). Gross profit estimates the value a company captures from its role in the value chain, which it can use to reward shareholders (dividends), invest in future growth (R&D), cover the cost of capital depreciation and pay its overhead expenses (marketing and administration) (Linden *et al.*, 2009).

[2] The classification of active and passive components is described in Section 3.1.

upstream activities comprise design, basic and applied R&D, downstream activities typically comprise marketing, distribution, brand management and after-sales services. Activities in the middle comprise manufacturing, assembly and other repetitious processes in which commercialized prototypes are implemented on a mass scale.

Based on his analysis of the computer industry's value chain, Acer founder Stan Shih (1996) argued that the value-added curve of the industry takes a smiling shape. The smiling curve shows that while higher value is created by both upstream and downstream firms (located at both the left and right side of the curve), such as component suppliers and lead firms, system assembly firms (located in the middle) add the lowest value (Figure 1). According to Shih, the major factors determining the level of value-added are entry barriers and accumulation of capability: the higher the entry barriers and the greater the accumulation of capabilities, the higher the value-added.[3] For example, the establishment of a brand name business in microprocessor manufacturing comes with high entry barriers such as intellectual property and brand equity, and requires many years of investment in R&D and marketing (branding), respectively. On the other hand, entry barriers and switching costs are lower for computer assembly because it is relatively easy to build the needed capabilities and therefore subject to rapid imitation and intense competition. In fact, Acer itself spun off its ODM business as a separate company, called Wistron, and concentrated its own efforts on developing its brand name business in order to avoid the commodity assembly trap.[4]

This research employs the resource-based theory and dynamic capabilities approach as well as industrial organization to analyze the concept. These theoretical approaches look at entry barriers but with different foci. Industrial organization focuses on industry forces, whereas the resource-based theory and dynamic capabilities approach focuses on resources and capabilities (difficult to replicate), respectively. However, they are closely related, and our research emphasizes the resource-based theory and dynamic capabilities approach.

2.2 Barriers to Entry: Resources and Dynamic Capabilities

Industrial organization economics considers entry barriers as the fundamental prerequisite for market power that confers large profits (monopoly rents) (Baumol *et al.*, 1982). It focuses on the external environment, emphasizing industry attractiveness as the primary basis for superior profitability. Observing that competition for profits goes beyond direct competitors, Porter (1980) extends the concept of industry rivalry based on five competitive forces that include customers, suppliers, potential entrants, substitute products and direct competitors. He argues that this extended rivalry defines an industry's structure and shapes the nature of

[3] Although Shih uses value-added for the "smiling curve" concept, he implicitly seems concerned with sustainable incomes (value capture) that are delivered to firms positioning themselves in different ways in global value chains.

[4] Acer, a leading manufacturer of notebook and desktop computers, spun off its contract manufacturing service unit as Wistron in 2001 when its sales were slumping in a weakening computer hardware market. By separating its branded and contract manufacturing operations, Acer could focus on its branded computer product operations. More recently, Asustek announced in December 2009 its plans to spin off its contract manufacturing unit as Pegatron Technology. The company was looking to focus more on creating its own branded line of business. In each case, the spinoff company was free to pursue other customers and gain economies of scale.

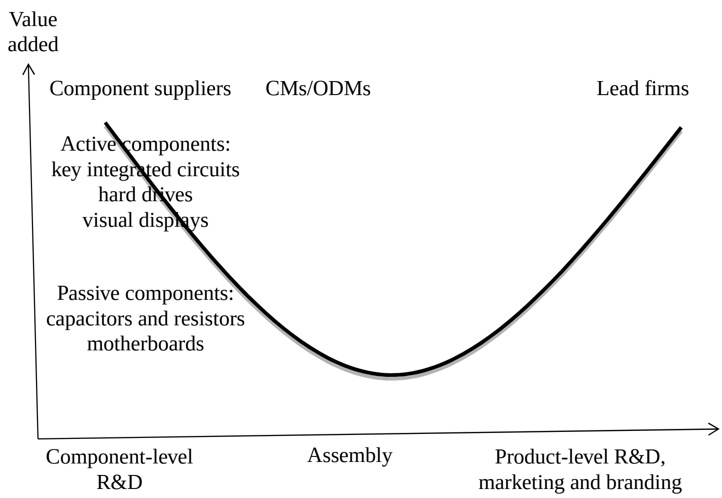

Figure 1. Smiling curve: adapted from Shih (1996)

competition within an industry; thus, firms should analyze their external environment, choose strategies that give them competitive advantage in that environment and then acquire the resources needed to implement their strategies. However, he places little emphasis on the importance of idiosyncratic firm attributes (e.g. resources) for a firm's competitive advantage.

By contrast, the resource-based theory suggests that in a rapidly changing environment in which customer demand is volatile, and technology is continually evolving, an externally focused orientation does not provide a secure foundation for formulating long-term strategy (Barney, 1991).[5] Although Porter tends to emphasize strategic positioning in terms of cost leadership, differentiation and focus as the primary source for superior profitability,[6] fundamental to strategic choices is the resource position of the firm: a firm gains and sustains large profits from resources that are rare, valuable, hard to imitate and immobile (Grant, 1991). Grant argues that barriers to entry are built up by resources that incumbent firms possess such as scale economies, patents, brand value and customer relationships, which new entrants can acquire only slowly or at disproportionate expense. Barney (1991) also argues that barriers to entry exist when competing firms are heterogeneous in terms of the strategic resources they control.

While resources include firms' tangible and intangible assets, capabilities refer to a firm's ability to appropriately deploy, coordinate and integrate its resources for production (Grant, 1991; Teece *et al.*, 1997; Coombs and Bierly, 2006). The dynamic capabilities

[5] The resource-based theory is related to the work of David Ricardo (1891), Joseph Schumpeter (1934) and Edith Penrose (1959). The returns to the resources that confer competitive advantage are referred to as Ricardian rents, compared to monopoly rents, that is, the returns to market power (Grant, 1991).

[6] Cost leadership, differentiation and focus are proposed by Porter (1980) as a set of generic strategies that can help firms gain competitive advantage in an industry.

approach explains the sources of competitive advantage over time in competitive markets (Teece and Pisano, 1994; Teece *et al.*, 1997). It emphasizes firm capabilities (difficult to replicate) for superior firm performance, which enable firms to sense changing customer demands and technological opportunities, seize the opportunities by developing new products through investments in tangible and intangible resources, and maintain competitiveness through enhancing, integrating, protecting and reconfiguring those resources (Teece, 2007). According to Teece (2007), in the fast changing global economy characterized by open innovation, outsourcing and offshoring, particularly in high-technology sectors, sustainable advantage requires more than the ownership of difficult-to-replicate knowledge assets. It also requires unique and difficult-to-replicate dynamic capabilities.[7] Chesbrough (2003) argues that as sources of innovation are geographically dispersed, firms reach out beyond their boundaries to access and integrate technology developed by others (i.e. open up technological opportunities through engaging in R&D and tapping into the research output of others).

Knowledge integration capability is critical for superior firm performance in such an open innovation environment, illustrated by the computer industry (Iansiti and Clark, 1994). Brusoni *et al.* (2001) argue that multi-technology firms, such as computer firms, need to have knowledge in excess of what they need for what they make. They outsource manufacturing while focusing on in-house concept design and system integration capabilities to coordinate the work of suppliers, who do new technology development and manufacturing. Knowledge assets embodied in people and organizational routines are not tradable and are hard to replicate in a market; thus, the creation, protection, integration and leverage of such intangible assets is critical for firms to achieve superior firm performance and avoid the zero-profit trap (Teece, 2007).

Morrison *et al.* (2008) argue that complex and tacit knowledge may affect the balance of power and the pattern of governance in global value chains. According to them, buyers (or in our case, lead firms and branded firms) are undisputed leaders since they coordinate and govern global value chains, based on knowledge of the whole product system as well as concept design, branding, marketing and system integration capabilities. Gereffi (1994) argues that global buyers can and do exert a high degree of control (or power) over spatially dispersed value chains by building global scale production and distribution systems without direct ownership. They manage such globally fragmented production networks and bring together all the pieces of the business into an integrated whole, for example, understand customer needs and integrate upstream (or component) innovations into new product developments.

On the upstream end, component suppliers also can generate sustainable high profits by possessing valuable resources such as intellectual property, superior design skills and the ability to commercialize new technologies (Gereffi, 2001; Gereffi *et al.*, 2005). Some suppliers of key components and technologies, such as Intel, Qualcomm, TI and Nvidia, are

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[7] Teece (2007) argues that supra competitive returns are earned through dynamic capabilities that enable entrepreneurship, innovation, semi-continuous asset orchestration, resource combinations and reconfiguration. The returns to dynamic capabilities are referred to as Schumpeterian rents, compared to Ricardian rents, that is, the returns to resources.

able to earn higher profits by controlling key standards, thereby holding dominant positions in some segments of the industry (Shin *et al.*, 2009).[8]

By contrast, firms in the middle of the value chain are not in a position to develop unique intellectual property, control key product standards, or develop strong brand names or customer relationships. They must compete largely on cost and operational excellence, and find it difficult to build any barriers to entry or create switching costs for their customers. Thus, we argue that in today's highly competitive global electronics industry, lead firms and component suppliers are in a better position to develop valuable resources, build barriers to entry and capture greater value. These theoretical arguments lead to the following hypothesis:

Hypothesis 1: Firms both at the upstream and downstream ends, such as component suppliers and brand name vendors, capture higher value than firms in the middle, such as CMs/ODMs.

2.3 Value Capture by Type of Component

Shih (1996) argues that the level of value-added from component manufacturing (activities at the upstream end of the value chain) differs by the types of components.[9] Active components, such as integrated circuits, visual displays and hard drives, generally require large capital investments and high-level manufacturing capabilities. These components are highly specialized, compared to passive components, such as capacitors and resistors, or printed circuit boards (e.g. motherboards), which are more standardized.[10] Active components are capable of a greater degree of differentiation and perhaps even branding, such as the "Intel inside" branding campaign. Performance aspects of active components are likely to be more visible to the final customers than other components. For example, most customers would recognize the difference between 50GB and 500GB hard drive while few would recognize the implications of improvements in the performance of capacitors or resistors. Therefore, active components are at the higher left side of the curve while passive components are lower on the curve. Shih (1996) ranked the level of value-added from component manufacturing in the following order (from high to low): software, microprocessor, DRAM, LCD, ASIC, monitor, HDD and motherboard. Therefore, we propose the following hypothesis:

Hypothesis 2: Firms manufacturing active components capture higher value than firms manufacturing passive components.

2.4 Value Capture by Country

According to Mudambi (2008), firms from advanced economies, those from emerging economies and those from recently developed countries are all conforming to the smiling

[8] According to Sturgeon (2003), since standards and protocols are dynamic, major advantages accrue to companies that actively participate in the rule-setting process, which favors established firms and locations. Most other value chain participants, such as CMs/ODMs, must adjust to the rules (or parameters) developed by those firms.

[9] We are grateful to anonymous reviewers for helping to clarify this discussion.

[10] Active components are those that require electrical power to operate. This could include the power supply, fans, storage device, transistors, diodes and other integrated circuits. Passive components such as the chassis, capacitors or enclosures do not require electrical power to operate.

curve: high-value activities at the downstream and upstream ends are largely concentrated in advanced economies, while low-value activities in the middle of the value chain are moving (or have moved) to emerging economies (Gereffi, 1999; Smakman, 2003; Pyndt and Pedersen, 2006). Firms based in advanced economies (so-called insiders), such as the Triad of North America, Europe and Japan, are more likely to capture higher value, compared to firms based in emerging economies such as Taiwan, China and Korea (Spencer, 2003; Mudambi, 2008; Shin *et al.*, 2009).[11] These established players were earlier entrants and established barriers to entry in many high-value segments of the industry. They continually innovate in order to maintain their competitive advantage, while startups such as Qualcomm, Broadcom and Nvidia have become highly profitable as fabless chip designers. A few emerging country firms have been able to develop successful brand names (e.g. Samsung, LG, Acer, HTC, Huawei) or compete in certain component markets (e.g. Samsung in memory chips and displays), but these are the exception. The innovations in developed countries are increasingly design driven, recognizing the highly diverse needs of individual markets. All these firms' design strategies are aimed at buttressing and enhancing the value of their brands (Mudambi, 2008). Hence, we propose the following hypothesis:

Hypothesis 3: Firms based in advanced economies capture higher value than firms in emerging economies.

3. Research Methods

In order to test the hypotheses proposed in the previous section, we employ the one-way analysis of variance (ANOVA—*F*-test) procedure, the non-parametric χ^2 (Kruskal and Wallis) and median tests.

Although the one-way ANOVA is a method of our choice for testing for differences between multiple groups, it assumes that the variances of the groups are equal and that the distribution of the test variable is reasonably normal. ANOVA is robust to unequal variances when the groups are of equal or near equal size. However, when both the variances and the sample sizes differ, we may need to transform the data (for example, the log transformation) or perform a non-parametric test (Norusis, 2004). Non-parametric procedures are designed to test for the significance of the difference between multiple groups when the assumptions of ANOVA are invalid or suspect. They make no assumptions about the mean and variance of a distribution, nor do they assume that any particular distribution is being used (Conover, 1980; Siegel and Castellan, 1988; Norusis, 2004). We employ the non-parametric χ^2 (Kruskal and Wallis) and median tests for the robustness of our analysis.

3.1 Data Sources and Coding

This study employs two data sources: the Electronic Business (EB) 300 data-set and the Hoovers database for the six years from 2000 to 2005. The EB 300 data-set includes

[11] Korea, and to an extent Taiwan, might be somewhere in between, as they have some major brand name companies like Samsung and Acer. They are also major suppliers of high-value components like LCDs and DRAM although they do not compete in software, microprocessors and specialized chips such as graphics. Taiwan and Korea also have far higher GDP per capita than China and most of South East Asian countries.

the top 300 electronics firms ranked by electronics revenue. The electronics revenue is derived from segmentation information and Reed Research estimates (Electronic Business, 2006). It includes revenue from the sale, service, license or rental of electronics/computer equipment, software or components. Data items such as sales, cost of goods sold (COGS), return on equity (ROE), return on assets (ROA), R&D expense and the number of employees are obtained from the Hoovers database for the same firms included in the EB 300 data-set.

For measures of value capture, we use gross profit (net sales minus cost of goods sold, which combines the wage bill with the cost of purchased inputs) and gross margin (the ratio of gross profit to net sales). We also employ net margin, ROA and ROE to measure a company's bottom-line financial performance.

Since we focus on three types of firms in the global electronics industry as lead firms, CMs/ODMs and component suppliers, we select only the firms operating in the following four industries: computer and peripheral equipment manufacturing, communications equipment manufacturing, audio and video equipment manufacturing, and semiconductor and other electronic component manufacturing.[12] The selection is based on the four-digit North American Industry Classification System (NAICS) code. The NAICS codes for the above four industries are 3341, 3342, 3343 and 3344, respectively.

We code these firms as lead firms, CMs/ODMs or component suppliers. Lead firms are branded firms at the head of a value chain and closest to distribution and retail. We only include firms if they can be classified as "pure" lead firm, CM/ODM or component supplier.[13]

Then, we classify component suppliers further into two categories: active and passive component suppliers.[14] A passive component refers to a component that consumes energy, but does not produce power. An active component is a component that produces power by consuming energy. We use the *Yearbook of World Electronics Data* (2003) for the classification. Active components include most key components, such as visual displays, hard drives and key integrated circuits. On the other hand, passive components include such components as capacitors, resistors, connectors and motherboards.

We also code these firms as firms based in advanced economies (insiders) and firms based in emerging economies (outsiders). Our samples include firms in 14 different countries, such as the USA, Canada, Germany, Switzerland, Netherlands, Finland, Sweden, France, Japan, Taiwan, South Korea, Singapore, Hong Kong and China. We classify North American, European and Japanese firms into firms in advanced economies, and other Asian firms into firms in emerging economies. The sample includes 622 observations for the six years from 2000 to 2005. The sample statistics are shown in Table 1.

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[12] Other industry segments are left out because most firms in those segments cannot be classified as pure lead firms, CMs/ODMs or component suppliers, and electronic revenue of those firms does not equal total revenue. Highly integrated firms or large conglomerates are not included since they have mixed sales figures such as sales from brand products, from contract manufacturing and from components.

[13] We compared the sample firms (622 observations for 2000–2005) and omitted firms (1,178 observations for 2000–2005) in terms of electronic revenue, gross margin, net margin, ROA and ROE. By conducting the ANOVA, the non-parametric χ^2 and median tests, we found that the omitted firms were not systematically different from the sample firms for all of the measures.

[14] We only include firms that can be classified as pure active and passive component suppliers. Diversified firms, as well as other types of firms, such as contract component manufacturers and storage firms are excluded.

Table 1. Sample statistics (2000–2005)

Variables	Lead firms			CMs/ODMs			Component suppliers		
	Mean	Std. dev.	Obs.	Mean	Std. dev.	Obs.	Mean	Std. dev.	Obs.
Sales (millions)	11,069.5	15,010.6	204	5,398.6	4,925.5	112	3,424.1	4,573.0	306
Gross profit (millions)	4,275.6	5,053.2	160	719.2	1,783.5	74	1,321.1	2,720.8	275
Gross margin (%)	31.90%	14.12%	160	10.67%	14.22%	74	32.29%	16.65%	275
Net profit (millions)	74.0	2,820.5	204	−27.8	589.2	106	31.7	3,523.3	304
Net margin (%)	0.61%	17.95%	204	−0.44%	8.83%	106	1.25%	24.63%	304
ROA (%)	0.97%	18.57%	163	0.04%	12.01%	94	−0.10%	31.47%	293
ROE (%)	−7.51%	154.2%	162	−2.24%	35.51%	90	−4.11%	101.5%	284
R&D expense (millions)	1,163.2	1,435.8	159	45.4	51.3	48	445.0	746.2	232
R&D ratio (% of sales)	8.36%	5.72%	159	0.90%	1.17%	48	11.38%	7.71%	232
S&GA costs (% of sales)	19.17%	7.64%	156	5.08%	5.92%	71	12.56%	6.48%	273
Employees (thousands)	35.0	36.2	160	28.7	35.4	92	16.6	16.4	274

4. Results

4.1 Comparison of Lead Firms, Component Suppliers and CMs/ODMs

Our results show that value captured by the three types of firms (lead firms, component suppliers and CMs/ODMs) are significantly different for gross margin, gross profit and net margin (Table 2): lead firms and component suppliers earn profits higher than CMs/ODMs. All three test statistics of ANOVA (except for net margin), non-parametric χ^2 and median tests are significant at a level of 0.001. However, the differences are minimal for ROA. On the other hand, CMs/ODMs perform better than lead firms and component suppliers in terms of ROE although it is negative for all three types of firms. The non-parametric χ^2 and median tests are significant at levels of 0.10 and 0.05, respectively. Our results also show that lead firms and component suppliers spend more on selling and general administration (S&GA) expense and invest more in R&D, compared to CMs/ODMs.

Positioned close to the consumer markets in the global value chain, lead firms specialize in high value-added activities such as R&D, product design, marketing and branding. They may have a well-known brand, better marketing and sales capabilities, and a keen understanding of

Table 2. ANOVA, non-parametric χ^2 (Kruskal–Wallis) and median test results (2000–2005)

		N	Mean	*F*	χ^2	Median test (χ^2)
Gross margin	Lead firms	160	32.3%	60.320***	131.887***	77.370***
	CMs/ODMs	74	10.7%			
	Comp. suppliers	275	31.9%			
Ln(gross profit)	Lead firms	160	7.57	65.776***	88.832***	40.567***
	CMs/ODMs	74	5.91			
	Comp. suppliers	272	6.54			
Net margin	Lead firms	204	0.61%	0.271	18.340***	19.816***
	CMs/ODMs	106	−0.44%			
	Comp. suppliers	304	1.25%			
ROA	Lead firms	163	0.97%	0.096	4.236	2.792
	CMs/ODMs	94	0.04%			
	Comp. suppliers	293	−0.10%			
ROE	Lead firms	162	−7.51%	0.074	4.617^{+}	6.055*
	CMs/ODMs	90	−2.24%			
	Comp. suppliers	284	−4.11%			
R&D/sales	Lead firms	159	8.36%	51.909***	116.291***	59.810***
	CMs/ODMs	48	0.90%			
	Comp. suppliers	232	11.38%			
Ln(R&D)	Lead firms	157	5.97	61.860***	89.110***	50.051***
	CMs/ODMs	47	3.30			
	Comp. suppliers	232	5.35			
S&GA/sales	Lead firms	156	19.17%	111.625***	185.980***	113.038***
	CMs/ODMs	71	5.08%			
	Comp. suppliers	273	12.56%			

Notes: ROA = return on assets; ROE = return on equity; S&GA = selling and general administration expense. The log transformation of net profit is not used because the number of observations with a negative value is high.
***$p < 0.001$; *$p < 0.05$; $^{+}p < 0.10$.

customers, compared to CMs/ODMs (Shin *et al*., 2009). Component suppliers, particularly suppliers of visual displays, hard drives or key integrated circuits, invest heavily in R&D and pursue high levels of innovation by embodying proprietary knowledge, compared to CMs/ODMs. Such capabilities as branding (for lead firms) and R&D (for component suppliers) create entry barriers and help lead firms and component suppliers gain higher profits. However, the costs of conducting R&D, sales and marketing can negatively affect both lead firms' and component suppliers' bottom-line financial performance. Net margins are still higher for lead firms and component makers than for CMs/ODMs, but while the difference is statistically significant, it is very small in practical terms. Lead firms and component makers both earn average gross margins of about 32 per cent, compared to 10 per cent for CMs/ODMs. However, the net margins are 0.61, 1.25 and −0.44 per cent, respectively (Table 2). We do not detect any significant differences in ROA among the three types of firms, and ROE is higher for CMs/ODMs, compared to lead firms and component suppliers. The reason might be that in contrast to ROA and ROE, net margin is not dependent on differences in asset intensity or equity (or debt) financing.[15] More significant from an investment perspective is the fact that ROE is negative for all three groups, illustrating how brutally competitive the electronics industry is.

Figure 2 depicts the means of gross margins of lead firms, component suppliers and CMs/ODMs. Interestingly, the shape of the mean plot is similar to the "smiling curve" shown in Figure 1.[16]

Figure 3 shows the mean plot for ROA, along with the mean plot for gross margin, for the three types of firms. The shape of the mean plot for ROA is somewhat distorted (tilted "smiling curve"), compared to the mean plot for gross margin.

Figure 4 shows the mean plot for ROE, along with the mean plot for gross margin, for the three types of firms. The shape of the mean plot for ROE looks the reverse of the "smiling curve".[17]

As mentioned earlier in Section 2.1, some lead firms, such as Acer and Asustek, separated their branded and contract manufacturing operations in order to focus more on their branded product operations. Motorola also spun off its upstream component business (chip fabrication) as Freescale Semiconductor, and outsourced more of its production. Such a strategy is consistent with our findings.

In order to directly examine if the spinoffs of these lead firms capture more value, we analyze the post-spinoff performance of Acer and Motorola.[18] Our results show that the

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[15] Our results for ROE might be influenced by the high leverage of CMs/ODMs. Since the leverage of those firms can be higher than lead firms and component suppliers, we analyze the differences of the debt-to-equity ratio for the three types of firms. The non-parametric median test shows that the debt-to-equity ratio is significantly higher for CMs/ODMs, compared to lead firms and component suppliers. However, the results are insignificant for the one-way ANOVA test and opposite for the Kruskal–Wallis χ^2-test.

[16] The lines are straight because the figure plots the means of gross margins of the three types of firms categorized into discrete variables.

[17] The differences in results between ROA and ROE look strange since the two measures are closely related. ROE can be decomposed into: ROE = net income/equity = net income/assets (ROA) × assets/equity (leverage). Therefore, when ROA increases, ROE may increase. However, ROE is also affected by leverage. Figure 4 shows the impact of the leverage of CMs/ODMs (please refer to footnote 15).

[18] We do not include Asustek in the analysis since its spinoff was announced fairly recently (December 2009). It would be interesting if future studies conduct the analysis with more firms, including not only lead firms, but also component suppliers, which have spun off their contract manufacturing or fabrication operations.

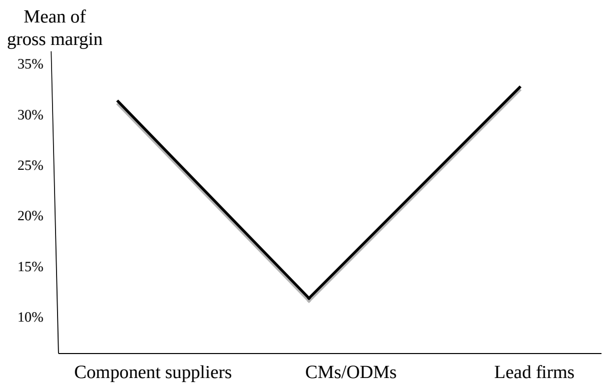

Figure 2. Mean plot for gross margin

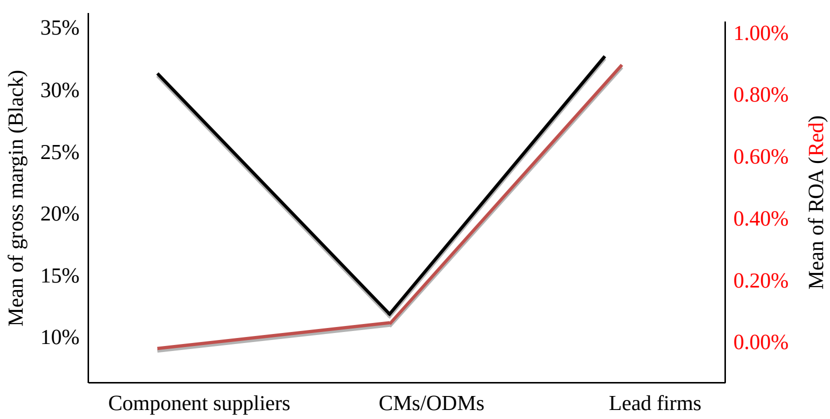

Figure 3. Mean plots for ROA and gross margin

companies' bottom-line financial performance has significantly improved after the spinoffs (Table 3). Acer's performance improved in 2002 after spinoff: ROA (from 0.9 to 7.9 per cent), ROE (from 1.7 to 13.0 per cent) and net margin (from 0.9 to 8.1 per cent). The performance of Motorola has also improved in 2005 after spinoff: ROA (from 5.0 to 12.8 per cent), ROE (from 11.5 to 27.5 per cent) and net margin (from 4.9 to 12.4 per cent). We also compare the post-spinoff performance of the two lead firms to the firms spun off (i.e. Acer vs. Wistron and Motorola vs. Freescale Semiconductor). Using the performance of three-year averages, we found that these lead firms (Acer and Motorola) have outperformed the spun-off firms (Wistron and Freescale Semiconductor), respectively, in terms of ROA, ROE and net margin. The comparison of the post-spinoff performance is shown in Table 4.

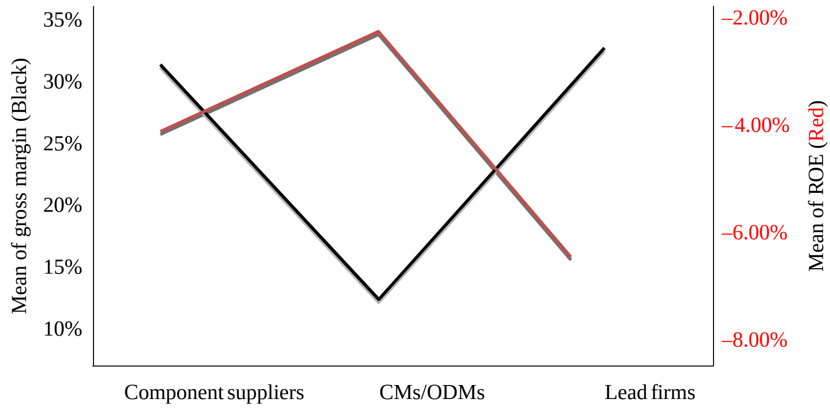

Figure 4. Mean plots for ROE and gross margin

4.2 Comparison of Active and Passive Component Suppliers

Table 5 shows that value captured by active and passive component suppliers is significantly different in terms of gross margin and gross profit: active component suppliers gain higher profits than passive component suppliers. All three test statistics of ANOVA, non-parametric χ^2 and median tests are significant at a level of 0.001. However, the differences are not significant for net margin and ROA. Passive component suppliers perform better than active component suppliers when ROE is employed as a performance measure (except for the median test).

Our results also show that active component suppliers invest heavily in R&D, compared to passive component suppliers. Such heavy investment in R&D enables active component suppliers to introduce new components to market and charge a high premium, thus earning higher gross profits. However, these higher margins are negated by the cost of conducting R&D, so their bottom-line financial performance measured as net margin and ROA is not significantly different from passive component suppliers, and their returns on equity are even lower than the ones for passive component suppliers.[19]

[19] We ran a regression analysis to examine the impact of R&D on gross profit, ROA and ROE of active and passive component suppliers. The analysis was conducted with R&D and a dummy for active component suppliers, along with an interaction term of active component suppliers and R&D. We found a significant coefficient on the interaction term for gross profit, but not for ROA and ROE. These results imply that R&D has a stronger impact on performance as measured by gross profit (i.e. value capture), but not by ROA and ROE, in active component suppliers as compared to passive component suppliers. These findings are consistent with our theoretical speculation that active component suppliers capture higher gross profits from their R&D investment, but the cost of conducting R&D negatively affects their bottom-line financial performance. We also examined the impact of R&D on gross profit, ROA and ROE of lead firms and passive component suppliers. We found similar results: a significant coefficient on the interaction term of lead firms and R&D for gross profit, but not for ROA and ROE. These results also imply that R&D has a stronger impact on gross profit, but not on ROA and ROE, in lead firms as compared to passive component suppliers. Overall, these findings are consistent with the results of our earlier work conducting a multivariate analysis for lead firms and non-lead firms (Shin *et al.*, 2009).

Table 3. Post-spinoff performance of Acer and Motorola

Company	Spinoff year	Year	ROA (%)	ROE (%)	Gross margin (%)	Net margin (%)	Sales (millions)	Firms spun off
Acer	2001	2003	6.2	11.3	13.4	4.6	4,622.5	Wistron
		2002	7.9	13.0	13.6	8.1	3,089.0	
		2001	**0.9**	**1.7**	**13.3**	**0.9**	**3,232.1**	
		2000	5.1	10.7	9.8	4.3	4,760.6	
Motorola	2004	2006	9.5	21.4	30.8	8.5	42,879.0	Freescale
		2005	12.8	27.5	32.0	12.4	36,843.0	Semiconductor, Inc.
		2004	**5.0**	**11.5**	**33.5**	**4.9**	**31,323.0**	
		2003	2.8	7.0	33.1	3.3	27,058.0	

Table 4. Comparison of post-spinoff performance (three-year average)—Acer vs. Wistron and Motorola vs. Freescale Semiconductor, Inc.

	Years	ROA (%)	ROE (%)	Gross margin (%)	Net margin (%)	Sales (millions)
Acer	2003–2005	5.57	11.93	9.50	4.23	6,144.2
Wistron		2.63	5.63	6.13	1.10	3,676.2
Motorola	2005–2007	7.43	16.30	30.00	6.93	38,781.3
Freescale		−5.41	−26.99	39.13	−18.42	6,066.4

Table 5. ANOVA, non-parametric χ^2 (Kruskal–Wallis) and median test results (2000–2005)

		N	Mean	*F*	χ^2	Median test (χ^2)
Gross margin	Active	161	37.38%	25.544***	25.293***	11.698***
	Passive	54	24.69%			
Ln(gross profit)	Active	158	6.80	21.150***	18.837***	14.312***
	Passive	54	6.09			
Net margin	Active	174	−1.06%	2.632	0.203	0.111
	Passive	63	5.26%			
ROA	Active	166	−2.75%	2.371	2.673	1.884
	Passive	63	5.17%			
ROE	Active	163	−3.77%	6.854**	4.369**	1.825
	Passive	61	16.63%			
R&D/sales	Active	149	14.37%	50.946***	43.131***	35.640***
	Passive	30	4.06%			
Ln(R&D)	Active	149	5.70	41.966***	34.913***	22.745***
	Passive	30	4.13			
S&GA/sales	Active	161	13.10%	0.001	0.016	0.627
	Passive	53	13.07%			

Notes: ROA = return on assets; ROE = return on equity; S&GA = selling and general administration expense. The log transformation of net profit is not used because the number of observations with a negative value is high.
***$p < 0.001$; **$p < 0.01$.

Table 6. ANOVA, non-parametric χ^2 (Kruskal–Wallis) and median test results (2000–2005)

		N	Mean	F	χ^2	Median test (χ^2)
Gross margin	Insiders	425	31.32%	49.789***	53.720***	32.624***
	Outsiders	84	17.42%			
Ln(gross profit)	Insiders	423	6.90	24.803***	25.114***	10.507***
	Outsiders	83	6.15			
Net margin	Insiders	443	−0.19%	3.647^{+}	1.625	0.918
	Outsiders	168	3.36%			
ROA	Insiders	438	−0.20%	0.632	2.514	5.050**
	Outsiders	112	1.95%			
ROE	Insiders	425	−5.65%	0.493	2.651	4.325**
	Outsiders	110	2.72%			
R&D/sales	Insiders	344	10.64%	78.201***	77.418***	70.219***
	Outsiders	94	3.69%			
Ln(R&D)	Insiders	343	5.66	66.933***	65.079***	52.629***
	Outsiders	92	4.20			
S&GA/sales	Insiders	421	14.74%	62.624***	76.384***	48.844***
	Outsiders	79	7.27%			

Notes: ROA = return on assets; ROE = return on equity; S&GA = selling and general administration expense. The log transformation of net profit is not used because the number of observations with a negative value is high.
***$p < 0.001$; **$p < 0.01$; $^{+}p < 0.10$.

4.3 Comparison of Firms in Advanced and Emerging Economies (Insiders and Outsiders)

Table 6 shows that firms based in advanced economies capture higher value in terms of gross margin and gross profit, compared to firms based in emerging economies. All three test statistics of ANOVA, non-parametric χ^2 and median tests are significant at a level of 0.001. However, the differences are trivial for net margin, ROA and ROE in the ANOVA F- and Kruskal–Wallis χ^2-tests.

As shown in Table 6, insiders (firms in advanced economies) spend more money on R&D and S&GA, compared to outsiders (firms in emerging economies). These firms earn high levels of profits by recognizing the highly diverse needs of individual markets and continually doing design-driven innovations.[20] However, these higher gross margins are offset by the costs of R&D, selling and marketing, and brand building activities, so their returns are not significantly different from the ones for firms in emerging economies.

In order to see if lead firms and component suppliers are concentrated more in advanced economies, rather than in emerging economies, we examine the distribution of lead firms, CMs/ODMs and component suppliers in the two economies. Table 7 (the rows of per cent within type) shows that there are more lead firms and component suppliers in advanced economies than in emerging economies (74.6 per cent vs. 25.4 per cent and 79.4

[20] Design-driven innovations could be either market- or technology-driven. While lead firms focus on market-driven innovations, that is, tailoring products to markets, component suppliers focus on technology-driven innovations. Some lead firms, such as Apple, do both market- and technology-driven innovations.

Table 7. Advanced and emerging economies (insiders and outsiders) by types of firms (2000–2005)

			Economies		
			Advanced economies	Emerging economies	Total
Type	Lead firm	Count	150	51	201
		% within type	74.6%	25.4%	100%
		% within economies	33.8%	29.1%	
	CM/ODM	Count	51	61	112
		% within type	45.5%	54.5%	100%
		% within economies	11.5%	34.9%	
	Component supplier	Count	243	63	306
		% within type	79.4%	20.6%	100%
		% within economies	54.7%	36.0%	
	Total	Count	444	175	619
		% within type	71.7%	28.3%	100%
		% within economies	100%	100%	

per cent vs. 20.6 per cent). On the other hand, CMs/ODMs are located more in emerging economies than in advanced economies (54.5 per cent vs. 45.5 per cent). Table 7 (the rows of per cent within economies) also shows that advanced economies have relatively more lead firms and component suppliers than CMs/ODMs (88.5 per cent vs. 11.5 per cent), compared to emerging economies (65.1 per cent vs. 34.9 per cent). These findings suggest that the three types of firms are not equally distributed across the two economies: that is, lead firms and component suppliers are largely concentrated in advanced economies. The test statistics of the Pearson χ^2 and likelihood ratio tests are significant at a level of 0.001. Figure 5 depicts the distribution of lead firms, CMs/ODMs and component suppliers in

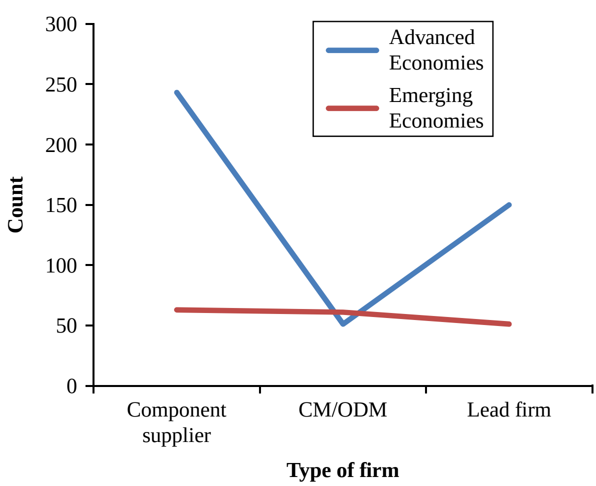

Figure 5. Distribution of types of firms in advanced and emerging economies

advanced and emerging economies. It illustrates that advanced economies conform to the smiling curve, but emerging economies do not.

5. Discussion and Conclusions

This research empirically analyzes the pattern of value capture in the global electronics industry. It demonstrates that lead firms and component suppliers, particularly suppliers of key components, capture most of the value created from a successful product in global production networks in which production and product development are outsourced to CMs and ODMs. Compared to CMs and ODMs, lead firms and component suppliers are in a position to build up higher entry barriers by deploying and integrating such resources as marketing, branding and intellectual property, thereby capturing higher profits.

The contribution of this research is threefold: first, it provides theoretical support for the smiling curve concept by showing that its predictions are consistent with theory from the resource-based view, dynamic capabilities and industrial organization. Although the concept has been used in prior research, it has not previously been analyzed in relation to existing theory. This research did so and found strong support.

Second, the research provides empirical evidence for the theoretical predictions. By applying the concept of the “smiling curve” to analyze value capture among lead firms, component suppliers and CMs/ODMs, it shows which firms are most likely to profit in global value chains. There has been limited empirical testing of the smiling curve argument in prior research.

Third, this research also sheds light on globalization of production networks by showing the importance of value chain position for capturing higher profit margins in today’s global electronics industry. For higher profits, a firm can either move downstream and develop brands or move upstream and develop innovative components. This is not easy in practice, as CMs and ODMs generally do not possess capabilities in either R&D or marketing, and face the potential loss of their CM/ODM business if they try to compete with their own customers. However, a few have made the transition from CM to brand name vendor (e.g. HTC) or divested their CM/ODM businesses to concentrate on their own brands (Acer, Asustek).

The “smiling curve” predictions are right if value is defined in terms of gross margins, but the cost of sustaining a position on either end of the curve (R&D for component suppliers and sales/marketing for brand name firms) is so high that returns on investment are similar across the curve. This is what basic economics would predict—if one segment or company is more profitable than others, then investors will bid up the price until its returns are normal. What is surprising is that the industry continues to sustain negative returns on equity on average. Perhaps many money-losing firms remain in business in the hope of developing a breakthrough product and turning their losses into gains.

From a national policy view, if the goal is to employ high-paid scientists, engineers and marketing people, then it makes sense to try to move into the upstream and downstream parts of the value chain, as higher margins captured from such positions in the value chain can support R&D and marketing activities. However, many developing countries cannot reasonably aspire to such a goal. It is important for policymakers in these countries to remember that the companies in the middle of the value chain still make gross profits and provide jobs for low- to moderate-skilled workers and some engineers and managers.

In addition, they provide an opportunity for learning and, possibly, for moving to a better position along the value chain.

The research suggests several directions for future work. This research categorizes firms into pure lead firm, CM/ODM or component supplier. Although value chains in the electronics industry have steadily disintegrated over the past several decades, there are still major firms, especially in Japan and Korea, with highly integrated operations. Since those firms can have mixed sales figures such as sales from brand products, from contract manufacturing and from components, it would be interesting to replicate the present analysis using sales percentages of different operations for firms to see if the current results still hold.

Future research could also focus on a particular industry such as the semiconductor industry where fabless chip companies such as Qualcomm and Nvidia outsource chip manufacturing to contract chip manufacturers (foundries). It would be interesting to examine who captures the most value in the global semiconductor industry by comparing fabless chip companies and contract chip manufacturers. Future research could also narrow down the scope into a particular country, such as Taiwan or China, and examine if the pattern of the value capture evidenced in this study holds for the country. Although this research discusses the impacts of innovation (R&D) and branding on value capture by firms in the global industry, it does not control for country economic variables in the analysis. Therefore, future research could provide additional understanding about value capture in the global electronics industry by incorporating such variables into an analysis.

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References

Barney, J. (1991) Firm resources and sustained competitive advantage, *Journal of Management*, 17, pp. 99–119.

Baumol, W. J., Panzer, J. C. and Willig, R. D. (1982) *Contestable Markets and the Theory of Industrial Structure* (New York: Harcourt Brace Jovanovitch).

Brusoni, S., Prencipe, A. and Pavitt, K. (2001) Knowledge specialization, organizational coupling, and the boundaries of the firm: why do firms know more than they make?, *Administrative Science Quarterly*, 46(4), pp. 597–621.

Chesbrough, H. (2003) *Open Innovation: The New Imperative for Creating and Profiting from Technology* (Boston: Harvard Business School Press).

Conover, W. J. (1980) *Practical Nonparametric Statistics*. 2nd edn (New York: John Wiley).

Coombs, J. E. and Bierly III, P. E. (2006) Measuring technological capability and performance, *R&D Management*, 36, pp. 421–438.

Electronic Business (2006) EB top 300 revenue.

Everatt, D., Tsai, T. and Chang, B. (1999) The Acer Group's China manufacturing decision. Richard Ivey School of Business Case Series #9A99M009, University of Western Ontario.

Gereffi, G. (1994) The organization of buyer-driven global commodity chains: how U.S. retailers shape overseas production networks, in: G. Gereffi & M. Korzeniewicz (Eds), *Commodity Chains and Global Capitalism* (London: Praeger).

Gereffi, G. (1999) International trade and industrial upgrading in the apparel commodity chain, *Journal of International Economics*, 48(1), pp. 37–70.

Gereffi, G. (2001) Shifting governance structures in global commodity chains, with special reference to the Internet, *American Behavioral Scientist*, 44(10), pp. 1616–1637.

Gereffi, G., Humphrey, J. and Sturgeon, T. (2005) The governance of global value chains, *Review of International Political Economy*, 12(1), pp. 78–104.

Grant, R. M. (1991) The resource-based theory of competitive advantage: implications for strategy formulation, *California Management Review*, 33(3), pp. 114–135.

Iansiti, M. and Clark, K. B. (1994) Integration and dynamic capability: evidence from product development in automobiles and mainframe computers, *Industrial and Corporate Change*, 3(3), pp. 557–605.

Linden, G., Kraemer, K. L. and Dedrick, J. (2009) Who captures value in a global innovation network? The case of Apple's iPod, *Communications of the ACM*, 52(3), pp. 140–144.

Morrison, A., Pietrobelli, C. and Rabellotti, R. (2008) Global value chains and technological capabilities: a framework to study learning and innovation in developing countries, *Oxford Development Studies*, 36(1), pp. 39–58.

Mudambi, R. (2007) Offshoring: economic geography and the multinational firm, *Journal of International Business Studies*, 38(1), p. 206.

Mudambi, R. (2008) Location, control and innovation in knowledge-intensive industries, *Journal of Economic Geography*, 8(5), pp. 699–725.

Norusis, M. (2004) *SPSS 13.0 Guide to Data Analysis* (Upper Saddle River, NJ: Prentice Hall).

Penrose, E. (1959) *The Theory of the Growth of the Firm* (New York: John Wiley).

Porter, M. (1980) *Competitive Strategy* (New York: Free Press).

Pyndt, J. and Pedersen, T. (2006) *Managing Global Offshoring Strategies: A Case Approach* (Copenhagen: Copenhagen Business School Press).

Ricardo, D. (1891) *Principles of Political Economy and Taxation* (London: G. Bell).

Schumpeter, J. A. (1934) *Theory of Economic Development* (Cambridge, MA: Harvard University Press).

Shih, S. (1996) *Me-Too is Not My Style: Challenge Difficulties, Break through Bottlenecks, Create Values* (Taipei: The Acer Foundation).

Shin, N., Kraemer, K. L. and Dedrick, J. (2009) R&D, value chain location and firm performance in the global electronics industry, *Industry and Innovation*, 16(3), pp. 315–330.

Siegel, S. and Castellan, N. J. (1988) *Nonparametric Statistics for the Behavioral Sciences* (New York: McGraw-Hill).

Smakman, F. (2003) Local industry in global networks: changing competitiveness, corporate strategies and pathways of development in Singapore and Malaysia's garment industry. PhD Dissertation, Utrecht University, the Netherlands.

Spencer, J. W. (2003) Firms' knowledge-sharing strategies in the global innovation system: empirical evidence from the flat panel display industry, *Strategic Management Journal*, 24(3), pp. 217–233.

Sturgeon, T. (2003) What really goes on in Silicon Valley? Spatial clustering dispersal in modular production networks, *Journal of Economic Geography*, 3, pp. 199–225.

Teece, D. J. (2007) Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance, *Strategic Management Journal*, 28, pp. 1319–1350.

Teece, D. J. and Pisano, G. (1994) The dynamic capabilities of enterprises: an introduction, *Industrial and Corporate Change*, 3(3), pp. 537–556.

Teece, D. J., Pisano, G. and Shuen, A. (1997) Dynamic capabilities and strategic management, *Strategic Management Journal*, 18, pp. 509–533.

The Yearbook of World Electronics Data. Vol. 2: America, Japan & Asia Pacific (2003).